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Boecking

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(54) **FUEL INJECTION DEVICE FOR INTERNAL COMBUSTION ENGINES**

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(58) **Field of Search** 239/88, 533.2, 239/533.3, 89–96, 533.8, 533.9; 123/447, 467, 446, 477, 478

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(57) **ABSTRACT**

In a fuel injection system for internal combustion engines including a plurality of injection valves connected to a fuel injection line and each having a nozzle chamber, a control chamber, a valve member controlling injection openings and which is actuatable counter to the action of a closing spring via a first control face acting in the valve opening direction, and via a second control face acting in the valve closing direction, one piston, displaceable in the compression direction, which on its face end defines a first compression chamber, for generating the injection pressure, one first valve for controlling the pressure buildup in the first compression chamber, and one second valve for controlling the pressure buildup in the control chamber. The piston, with an annular shoulder, defines a second compression chamber communicating with the control chamber.

12 Claims, 2 Drawing Sheets

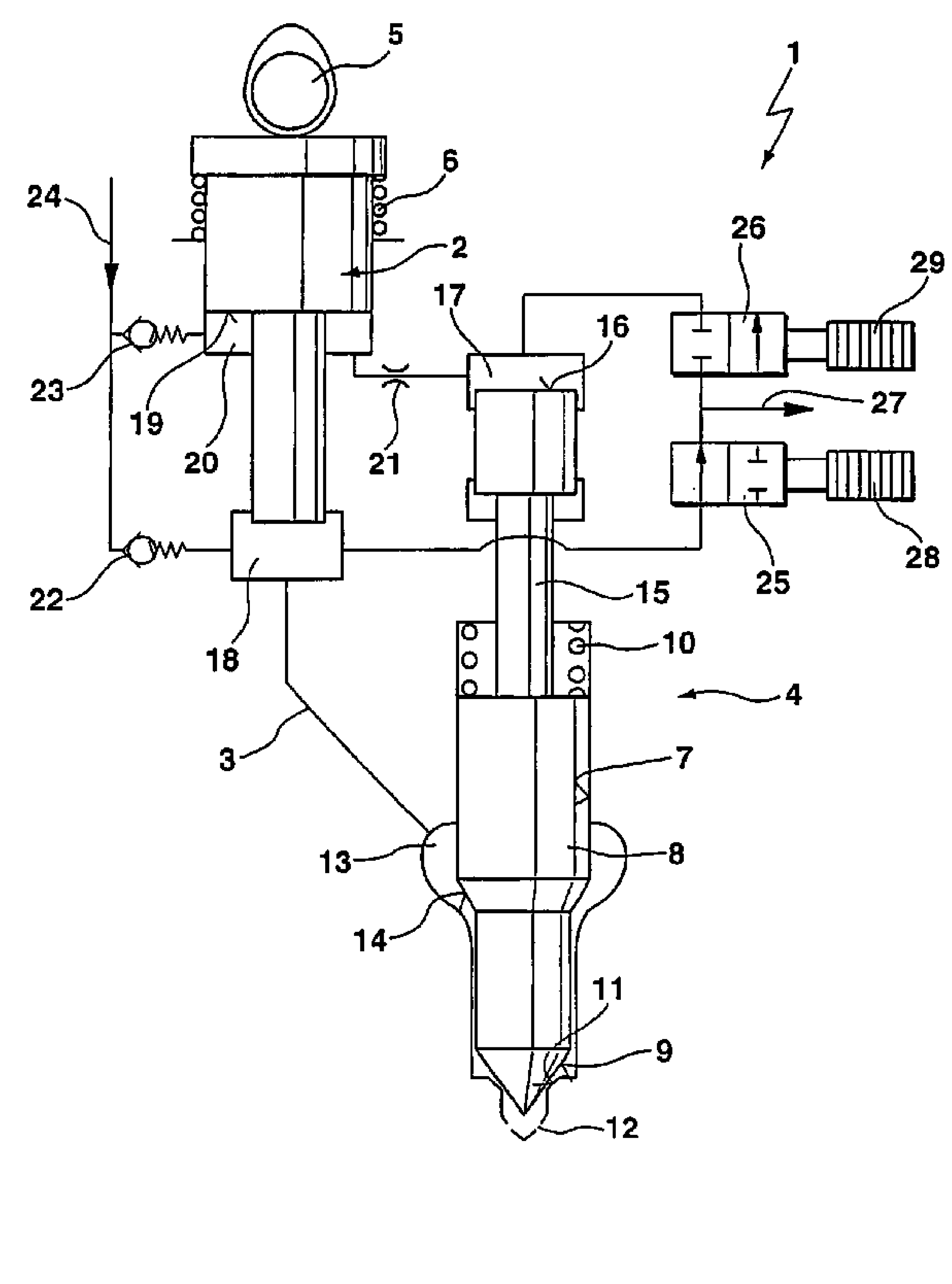


Fig. 1

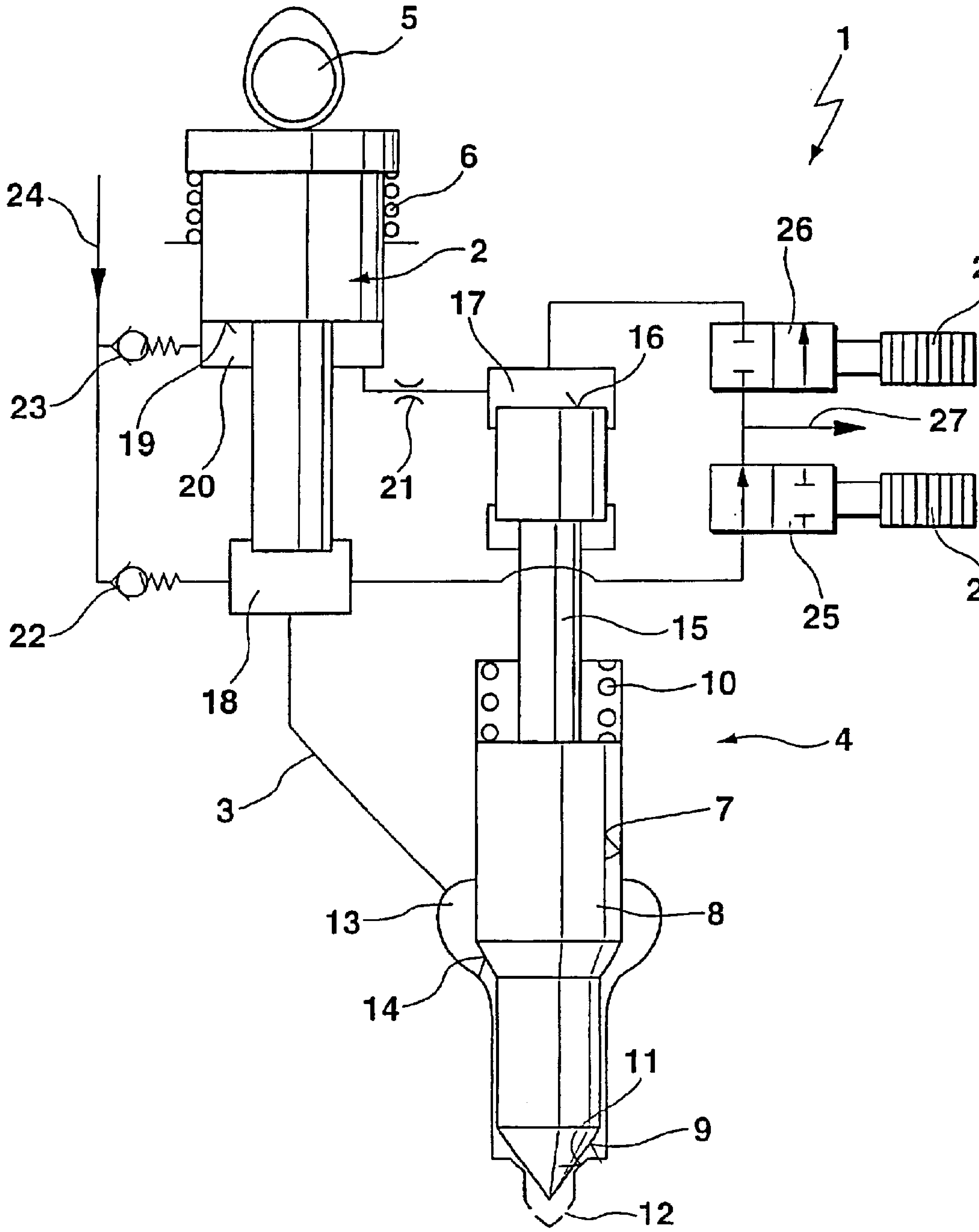
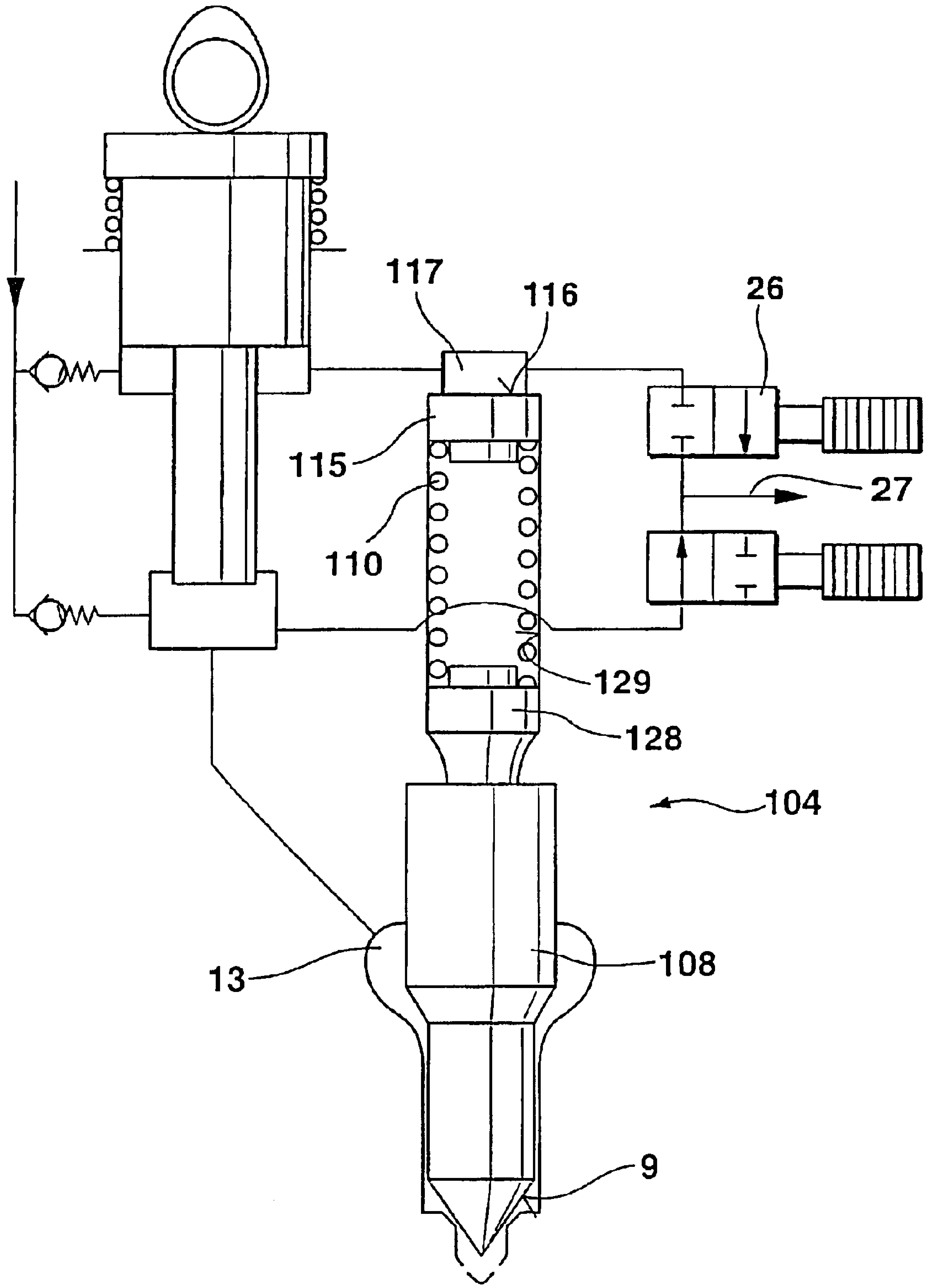


Fig. 2



FUEL INJECTION DEVICE FOR INTERNAL COMBUSTION ENGINES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a 35 USC 371 application of PCT/DE 02/03449 filed on Sep. 14, 2002.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is directed to an improved fuel injection system including a plurality of injectors for injecting fuel into the cylinders of an internal combustion engine.

2. Description of the Prior Art

In a fuel injection system of illustrated in FIG. **1** of German Patent Disclosure DE 199 39 419 A1, the injection pressure is also used as the control pressure for a control chamber. For a preinjection and a postinjection, a local pressure reservoir is necessary.

SUMMARY OF THE INVENTION

The fuel injection system of the invention has the advantage over the prior art that by means of a stepped piston, the high pressure for the injection and the control pressure for the control chamber are generated separately from one another. As a result, preinjections and/or postinjections that are controllable exactly are possible.

BRIEF DESCRIPTION OF THE DRAWINGS

Two exemplary embodiments of the fuel injection system of the invention are explained in further detail in the ensuing description, taken in conjunction with the drawings, in which:

FIG. **1** schematically shows the essential components of a first fuel injection system of the invention, with a graduated pump piston and with a closing piston acting on the valve member; and

FIG. **2** schematically shows the essential components of a second fuel injection system of the invention, with a graduated pump piston and with a deflection piston acting on the valve member.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The fuel injection system shown in FIG. **1** for an internal combustion engine includes a unit injector (UI) **1**, in which the fuel is compressed to a higher injection pressure by means of a pump piston **2** and is carried away via an injection line **3** to an injection valve (injector) **4** protruding into the combustion chamber of the engine to be supplied. One unit injector **1** per engine cylinder is built into a cylinder head. The pump piston **2** is driven by a cam **5** of the engine camshaft counter to the action of a restoring spring **6**.

In an axial guide bore **7** of the injection valve **4**, a pistonlike valve member (nozzle needle) **8** with a conical valve sealing face **9** is displaceably supported; this face is pressed by a closing spring **10** against a conical valve seat face **11** of the valve housing and closes the injection openings **12** provided there. The injection line **3** discharges in the injection valve **4** into an annular nozzle chamber **13**, from which an annular gap between the guide bore **7** and the valve member **8** extends as far as the valve seat face **11**. In the region of the nozzle chamber **13**, the valve member **8** has a first control face **14**, embodied as a pressure shoulder, at which the fuel delivered via the injection line **3** engages the valve member **8** in the opening direction (that is, inward). The face end of the valve member **8** remote from the valve sealing face **9** is engaged by a closing piston **15**, whose face end remote from the valve sealing face **9** forms a second control face **16**. The second control face **16** defines a control chamber **17** and acts in the valve closing direction.

The pump piston **2**, with its face end remote from the cam **5**, defines a first compression chamber **18** communicating with the injection line **3**, and with an annular shoulder **19**, it defines a second compression chamber **20**, which communicates with the control chamber **17** via a throttle **21**. The two compression chambers **18**, **20** each communicate via a respective check valve **22**, **23** with a supply line **24** for the fuel. The first compression chamber **18**, from which the injection line **3** begins, can be made to communicate via a first valve **25**, and the control chamber **17** can be made to communicate via a second valve **26**, with a relief line (leak fuel) **27**. The two valves **25**, **26** are embodied as 2/2-way valves with piezoelectric actuators **28**, **29**. In the first compression chamber **18**, the high pressure for the injection is generated, and in the second compression chamber **20**, the high pressure for the control function of the control chamber **17** is generated. The second control face **16** is larger than the first control face **14**, so that when the valves **25**, **26** are closed and there is an identical high pressure in the nozzle chamber **13** and in the control chamber **17**, the valve member **8** closes the injection openings **12**.

During the pumping stroke of the pump piston **2**, the two compression chambers **18**, **20** are filled with fuel via the supply line **24**. By means of the compression stroke of the pump piston **2**, when both valves **25**, **26** are closed, the fuel located in the compression chambers **18**, **20** is compressed to a higher pressure; the check valves **22**, **23** prevent the return flow of compressed fuel back into the supply line **24**.

During the compression stroke of the pump piston **2** and with the control chamber **17** pressure-relieved (that is, with the second valve **26** open), the onset of the injection event is initiated by closure of the first valve **25**. The higher injection pressure builds up in the first compression chamber **18** and thus in the nozzle chamber **13** as well. As soon as the fuel pressure prevailing in the nozzle chamber **13** suffices to open the valve member **8** under pressure control, counter to the action of the closing spring **10**, the fuel is injected into the combustion chamber. If the second valve **26** is now closed as well, then a higher fuel pressure builds up in the second compression chamber **20** and thus in the control chamber **17** as well. The control chamber **17** is no longer pressure-relieved, and so the valve member **8** closes the injection openings **12**. Opening the second valve **26** relieves the control chamber **17** of pressure again, and the valve member **8** opens under stroke control, so that a postinjection at the fuel pressure prevailing in the nozzle chamber **13** is performed. If the fuel pressure prevailing in the nozzle chamber **13** no longer suffices to open the valve member **8**, then the closing spring **10** closes the valve member **8**, and the injection event is ended.

The fuel injection system shown in FIG. **2**, instead of a closing piston, uses a deflection piston **115**, whose face end remote from the valve sealing face **9** forms the second control face **116** and defines the control chamber **117**. The closing spring **110** is braced on the end of the deflection piston **115** remote from the second control face **116** and on a head **128** of the valve member **108**. The deflection piston **115** and the head **128** are guided displaceably in a common axial guide bore **129** of the injection valve **104**.

When the second valve **26** is open, the control chamber **117** is pressure-relieved via the relief line **27**, and the deflection piston **115** is displaced into its outermost position in the valve opening direction, so that the fuel pressure prevailing in the nozzle chamber **13** suffices to open the valve member **108** counter to the closing spring **110**. When the second valve **26** is closed, the deflection piston **115** is displaced in the valve closing direction by the fuel pressure prevailing in the control chamber **117**, and as a result the closing spring **110** is compressed so much that the fuel pressure prevailing in the nozzle chamber **13** no longer suffices to open the valve member **108**.

The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

I claim:

1. In a fuel injection system for internal combustion engines, having a plurality of injection valves (**4**; **104**), each provided in a respective fuel injection line (**3**), which valves each have one nozzle chamber (**13**), one control chamber (**17**; **117**), one valve member (**8**; **108**), which controls the injection openings (**12**) of the nozzle chamber (**13**) and which is actuatable counter to the action of a closing spring (**10**; **110**) via a first control face (**14**), located in the nozzle chamber (**13**) and acting in the valve opening direction, and via a second control face (**16**; **116**), located in the control chamber (**17**; **117**) and acting in the valve closing direction, one piston (**2**), displaceable in the compression direction, which on its face end defines a first compression chamber (**18**), communicating with the injection line (**3**), for generating the injection pressure, one first valve (**25**) for controlling the pressure buildup in the first compression chamber (**18**), and one second valve (**26**) for controlling the pressure buildup in the control chamber (**17**; **117**),

the improvement wherein the piston (**2**) comprises an annular shoulder (**19**), which defines a second compression chamber (**20**) communicating with the control chamber (**17**; **117**).

2. The fuel injection system of claim **1**, further comprising a closing piston (**15**) having a face end forming the second control face (**16**), the closing piston (**15**) resting at its other end on the valve member (**8**).

3. The fuel injection system of claim **1**, further comprising a deflection piston (**115**) having a face end (**115**) forming the second control face (**116**), the closing spring (**110**) of the valve member (**108**) being braced on the other end of the deflection piston (**115**).

4. The fuel injection system of claim **1**, wherein the two compression chambers (**18**, **20**) each communicate via a respective check valve (**22**, **23**) with a fuel supply line (**24**).

5. The fuel injection system of claim **2**, wherein the two compression chambers (**18**, **20**) each communicate via a respective check valve (**22**, **23**) with a fuel supply line (**24**).

6. The fuel injection system of claim **3**, wherein the two compression chambers (**18**, **20**) each communicate via a respective check valve (**22**, **23**) with a fuel supply line (**24**).

7. The fuel injection system of claim **1**, further comprising a cam (**5**) that drives the piston (**2**) counter to the action of a restoring spring (**6**).

8. The fuel injection system of claim **2**, further comprising a cam (**5**) that drives the piston (**2**) counter to the action of a restoring spring (**6**).

9. The fuel injection system of claim **3**, further comprising a cam (**5**) that drives the piston (**2**) counter to the action of a restoring spring (**6**).

10. The fuel injection system of claim **4**, further comprising a cam (**5**) that drives the piston (**2**) counter to the action of a restoring spring (**6**).

11. The fuel injection system of claims **5**, further comprising a cam (**5**) that drives the piston (**2**) counter to the action of a restoring spring (**6**).

12. The fuel injection system of claim **6**, further comprising a cam (**5**) that drives the piston (**2**) counter to the action of a restoring spring (**6**).

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